VERDIGRIS BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Big Hill Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Middle Verdigris

County: Neosho, Labette and Montgomery

HUC 8: 11070103

HUC 11 (HUC 14s)**:** **010** (060, 070 and 080)

Drainage Area: 111.1 square miles

Main Stem Segments: WQLS: 30 and 32 (Big Hill Creek) starting at confluence with the Verdigris River and traveling upstream to headwaters in southwestern Neosho County (**Figure 1**).

Tributary Segments: WQLS: Potatoe Creek (31)
Non-WQLS: Wildcat Creek (60)

Designated Uses: Expected Aquatic Life Support, Primary Contact Recreation, Domestic Water Supply; Food Procurement; Ground Water Recharge; Industrial Water Supply Use; Irrigation Use; Livestock Watering Use for Main Stem Segments 30 and 32.

1998 303(d) Listing: Table 1 - Predominant Non-point Source and Point Source Impacts

Impaired Use: Expected Aquatic Life Support

Water Quality Standard: Dissolved Oxygen (DO): 5 mg/L (KAR 28-16-28e(c)(2)(A))

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303(d): Not Supporting Aquatic Life

Monitoring Sites: Station 607 near Avian

Period of Record Used: 1991, 1995 and 1999 for Station 607; 2000 and 2001 Kansas Biological Survey Data (**Figure 2**)

Flow Record: Big Hill Creek near Cherryvale (USGS Gage Station 07170700)

Long Term Flow Conditions: 10% Exceedence Flows = 60.6 cfs**,** 95% = 0 cfs

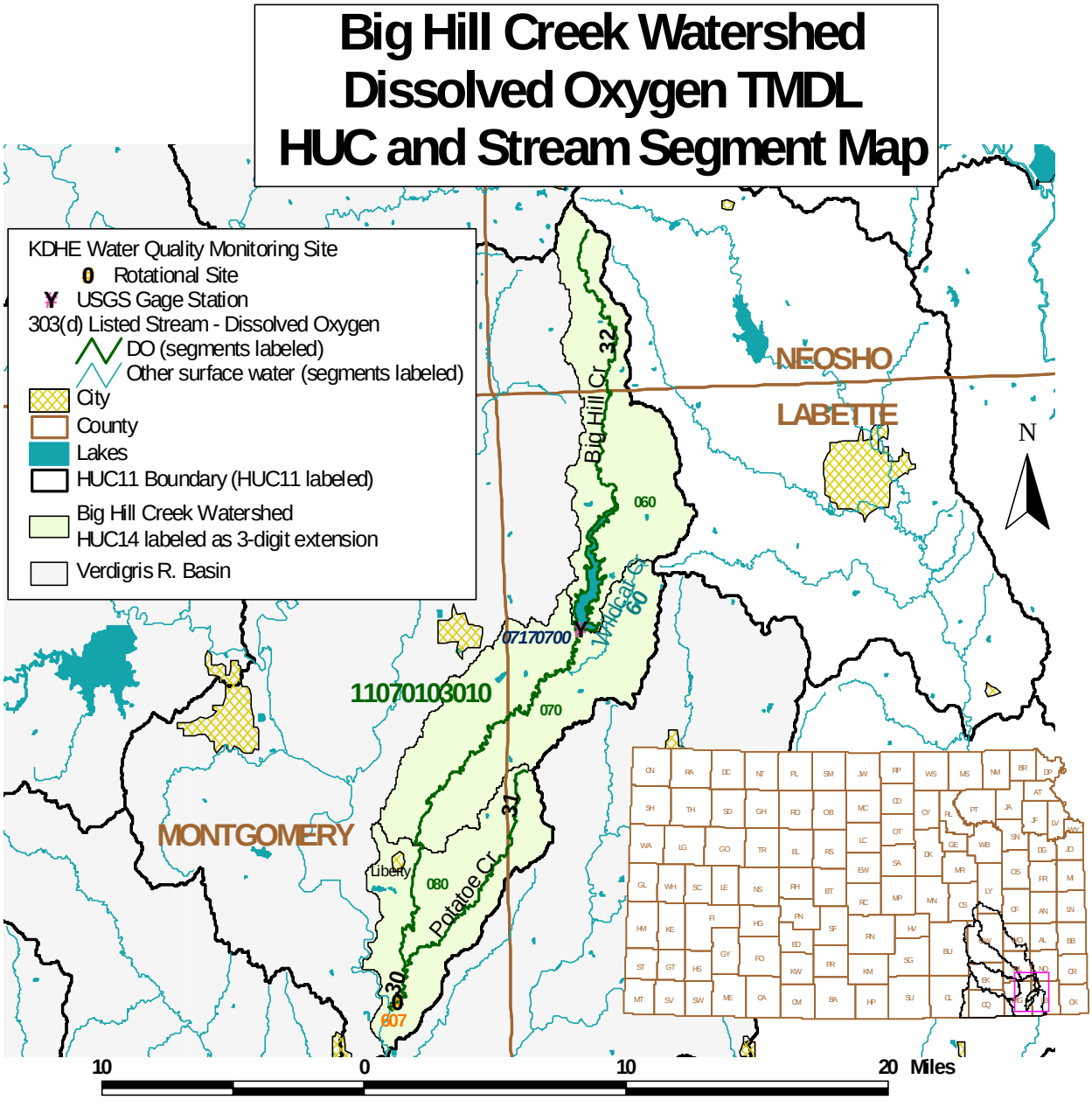

Figure 1

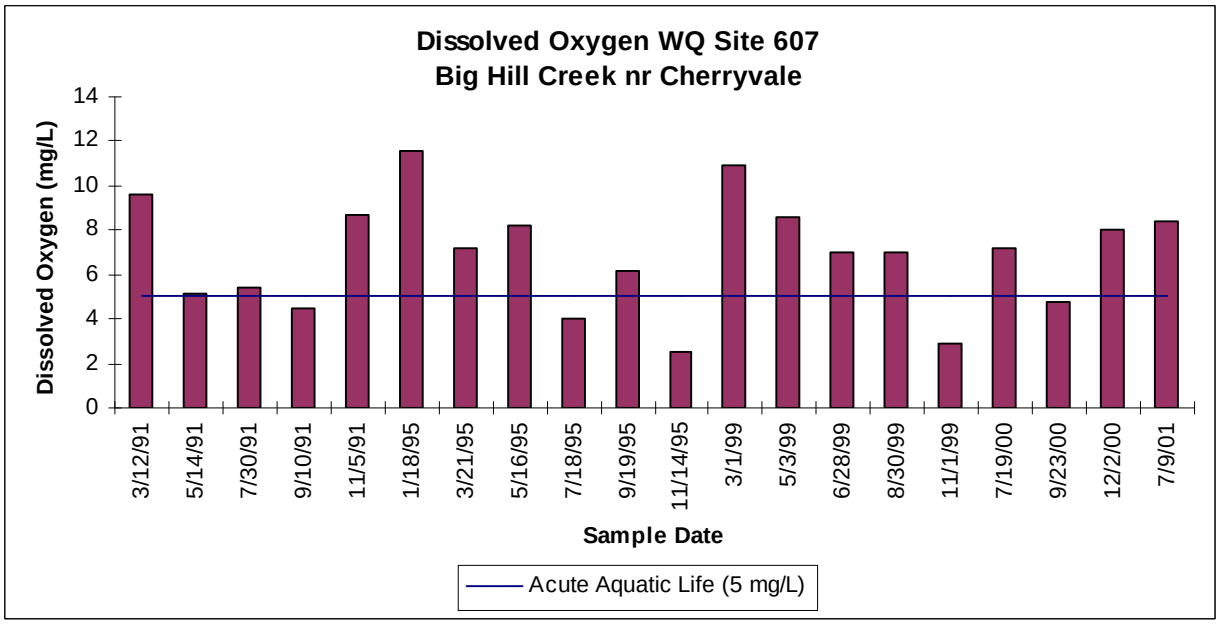

Figure 2

Current Conditions: Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling site were categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-Fall (Aug-Oct) and Winter (Nov-Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Load curves were established for the Aquatic Life criterion by multiplying the flow values for Big Hill Creek near Cherryvale along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of pounds of DO per day. This load curve graphically displays the TMDL since any point along the curve represents water quality at the standard at that flow. Historic excursions from water quality standards (WQS) are seen as plotted points *below* the load curves. Water quality standards are met for those points plotting *above* the applicable load duration curves (**Figure 3**).

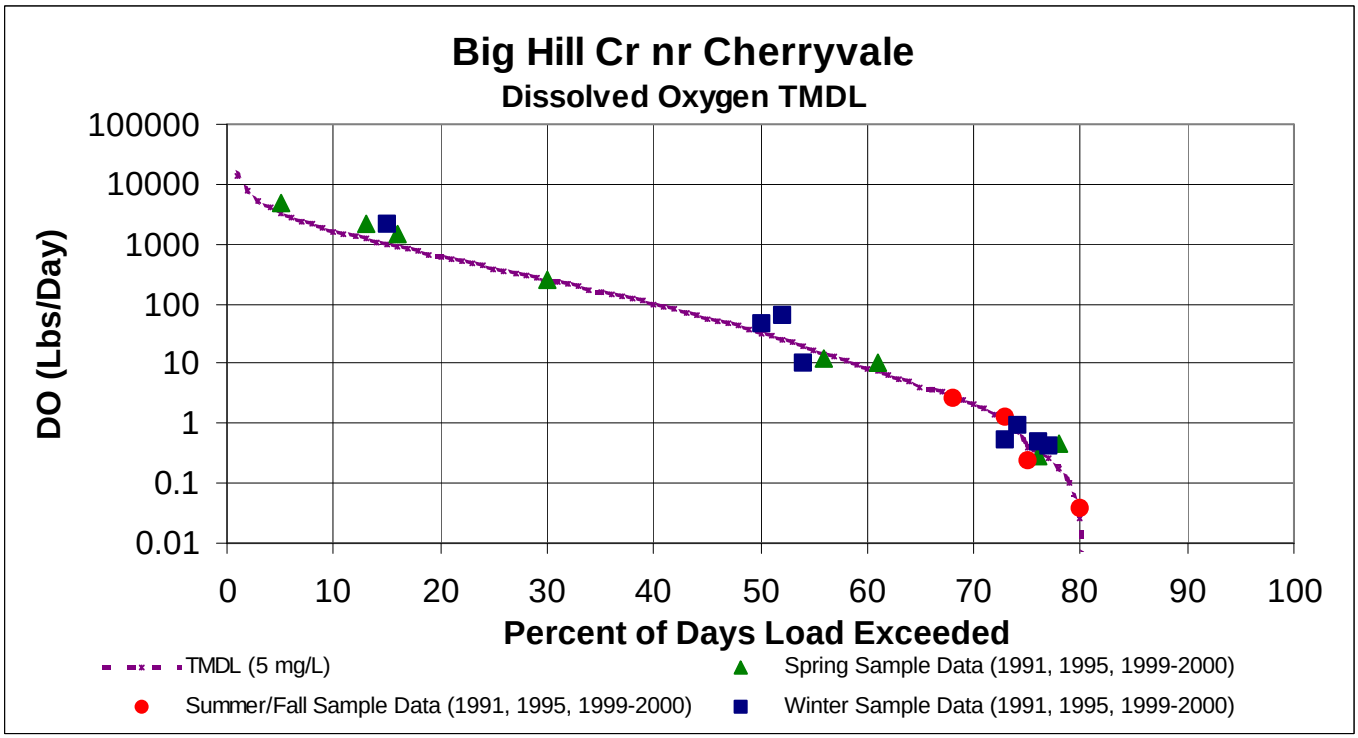

Figure 3

Excursions were seen in all seasons and are outlined in **Table 1**. Fifty percent of the Summer-Fall samples and 13% of the Spring samples were below the aquatic life criterion. Twenty five percent Winter samples were under the aquatic life criterion. Overall, 25% of the samples were under the criterion. This would represent a baseline condition of non-support of the impaired designated use.

No DO violations have been encountered at flows exceeding 0.72 cfs on Big Hill Creek near Cherryvale, therefore a critical low flow can be identified on Big Hill Creek as those flows of 0.72 cfs or less.

Table 1
NUMBER OF SAMPLES UNDER DISSOLVED OXYGEN STANDARD OF 5 mg/L BY FLOW

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Big Hill Creek near Cherryvale (607)	Spring	0	0	0	1	0	0	1/8 = 13%
	Summer	0	0	0	1	1	0	2/4 = 50%
	Winter	0	0	0	2	0	0	2/8 = 25%

A watershed comparison approach was taken in developing this TMDL. The Middle Caney Creek watershed (Water Quality Sampling Site 694 in the watershed was not impaired by low DO) has differing land use characteristics (**see Table 2 in Appendix**) to the Big Hill Creek watershed, but is of similar size and is located west of the Big Hill Creek watershed in the Verdigris River Basin. The relationship of DO to ammonia, biochemical oxygen demand (BOD), fecal coliform bacteria (FCB), water temperature, turbidity, nitrate, phosphorus, pH and total suspended solids (TSS) were used in the comparison.

Table 3 in the Appendix outlines those water quality data for the samples taken within one day for the two sites of interest. **Table 4 in the Appendix** is the subset of data from Table 3 for those sample dates when DO was below the aquatic life criterion for sample site 607. From Table 4 at site 607 certain averages were slightly higher than the reference cite. The average BOD and phosphorus were higher than the reference site 694 while all other parameters were comparable. For one of these comparison dates (11/1/99), even the reference site experienced low DO.

In addition to the comparison provided in Table 4, there were two samples dates, 9/19/95 and 8/30/99, at site 607 (**see Table 5 in the Appendix**) when the flow was within the critical flow range yet DO was not violated. On both of these sample dates, BOD and phosphorus were much lower than the averages in Table 4 for site 607.

Because the BOD average was higher at site 607 than the comparison averages in Tables 4 and 5 in the Appendix, the indication is that, in addition to the naturally driven factor of lower flow which can contribute to the occasional DO excursions, a probable oxygen demanding substance load is being added to the Big Hill Creek watershed upstream of site 607 and, under certain conditions, is likely a factor influencing the DO violations.

Desired Endpoints of Water Quality at Site 607 over 2007 - 2011

The desired endpoint will be a biochemical oxygen demand from artificial sources such that average BOD concentrations remain below 2.4 mg/l in the stream under the critical flow conditions which results in no excursions below 5 mg/l of DO detected between 2007 - 2011 attributed to these sources.

This desired endpoint should improve DO concentrations in the creek at the critical lower flows (0 - 0.72 cfs). Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow usually occurring in the July - November months.

This endpoint will be reached as a result of expected, though unspecified, reductions in organic loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL (see Implementation - Section 5). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows which, in turn, should help reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period. Achievement of this endpoint will provide full support of the aquatic life function of the creek and attain the dissolved oxygen water quality standard.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There is one NPDES permitted wastewater discharger within the watershed (**Figure 4**) upstream of Site 607. This system is outlined below in **Table 6**.

Table 6

DISCHARGING FACILITY	STREAM REACH	SEGMENT	DESIGN FLOW	TYPE
Liberty WTF	Big Hill Creek	32	0.018 mgd	Lagoon

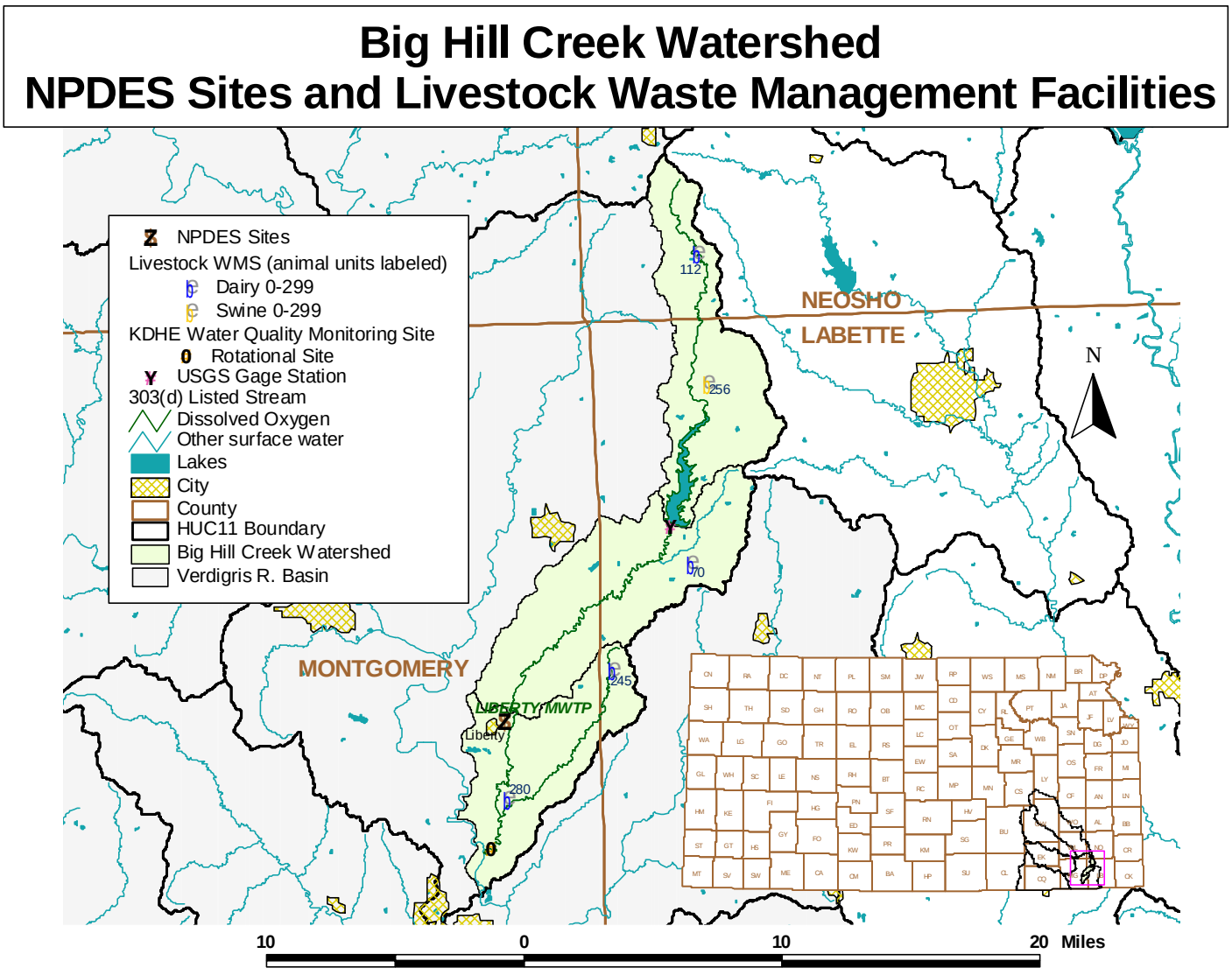

Figure 4

The city of Liberty relies on a three cell lagoon system with 120 day detention times for treatment of their wastewater. Kansas Implementation Procedures - Waste Water Permitting - indicates this lagoon meets standard design criteria which have been shown to consistently meet or exceed the bacteria standard.

The population projection for Liberty to the year 2020 indicates slight declines. Projections of future water use and resulting wastewater appear to be within the design flows for of the current system's treatment capacity. Examination of 1998, 1999, 2000 and 2001 effluent monitoring from the city indicates that, when the city does discharge, which is very rare (6 months out of 48), BOD is usually well within permit limits. The stream flow records on Big Creek were reviewed for those dates (see attached flow condition review) that the city did discharge and it was noted that discharges occurred only after large runoff events in the watershed, indicating that the city contributes BOD loads to the stream outside of the critical flow period (0 - 0.72 cfs) identified for

this TMDL. In the instances when Liberty did discharge during this period, effluent monitoring indicates BOD discharges in excess of permit limits occurred only once and this one BOD permit exceedance occurred within 8 days of two consecutive runoff events whose peak discharges were 4 percent and 2 percent in flow exceedance. It is concluded that wastewater from Liberty was not the cause of the DO impairment in Big Hill Creek.

Livestock Waste Management Systems: Five operations are registered, certified or permitted within the watershed. These facilities (mostly dairies) are evenly distributed across the watershed (**Figure 3**). All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed for the 25 year, 24 hour rainfall/runoff event, which typically coincide with stream flows exceeded less than 1 - 5 % of the time. NPDES permits, also non-discharging, are issued for facilities with more than 1,000 animal units. None of the facilities in the watershed are of this size. Total potential animal units within the watershed for all facilities is 963. The actual number of animal units on site is variable, but typically less than potential numbers.

Land Use: Most of the watershed is grassland (57% of the area), cropland (33%), or woodland (7%). Most of the cropland is located in either the upper or lower third of the watershed. The grazing density estimate is average in the lower third of the watershed and high in the upper two thirds of the watershed when compared to densities elsewhere in the Verdigris Basin (32-58 animal units/mi^2) (**Figure 5 or Table 2 in Appendix**).

On-Site Waste Systems: The watershed's population density is average in the lower two thirds of the watershed and low in the upper third of the watershed when compared to densities across the Verdigris Basin (9-26 person/mi^2) (**Figure 5**). The rural population projections for Labette and Montgomery counties through 2020 show slight to modest growth (3-10% increase). While failing on-site waste systems can contribute oxygen demanding substance loadings, their impact on the impaired segments is generally limited, given the small size of the rural population and magnitude of other sources in the watershed.

Contributing Runoff: The Big Hill Creek watershed's average soil permeability is 0.7 inches/hour according to NRCS STATSGO data base. Most of the watershed produces runoff even under relatively low (1.71"/hr) potential runoff conditions (90.4%). Under very low (1.14"/hr) potential conditions, this potential contributing area is reduced to about 66%. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.57"/hr of rain will still generate runoff from 61% of this watershed, chiefly from the upper and lower third of the watershed and along the stream channels.

Background Levels: Some organic enrichment may be associated with environmental background levels, including contributions from wildlife and stream side vegetation, but it is likely that the density of animals such as deer is fairly dispersed across the watershed and that the loading of oxygen demanding material is constant along the stream. In the case of wildlife, this loading should result in minimal loading to the streams below the levels necessary to violate the water quality standards. In the case of stream side vegetation, the loading should be greater toward the lower half of the watershed downstream of Big Hill Lake.

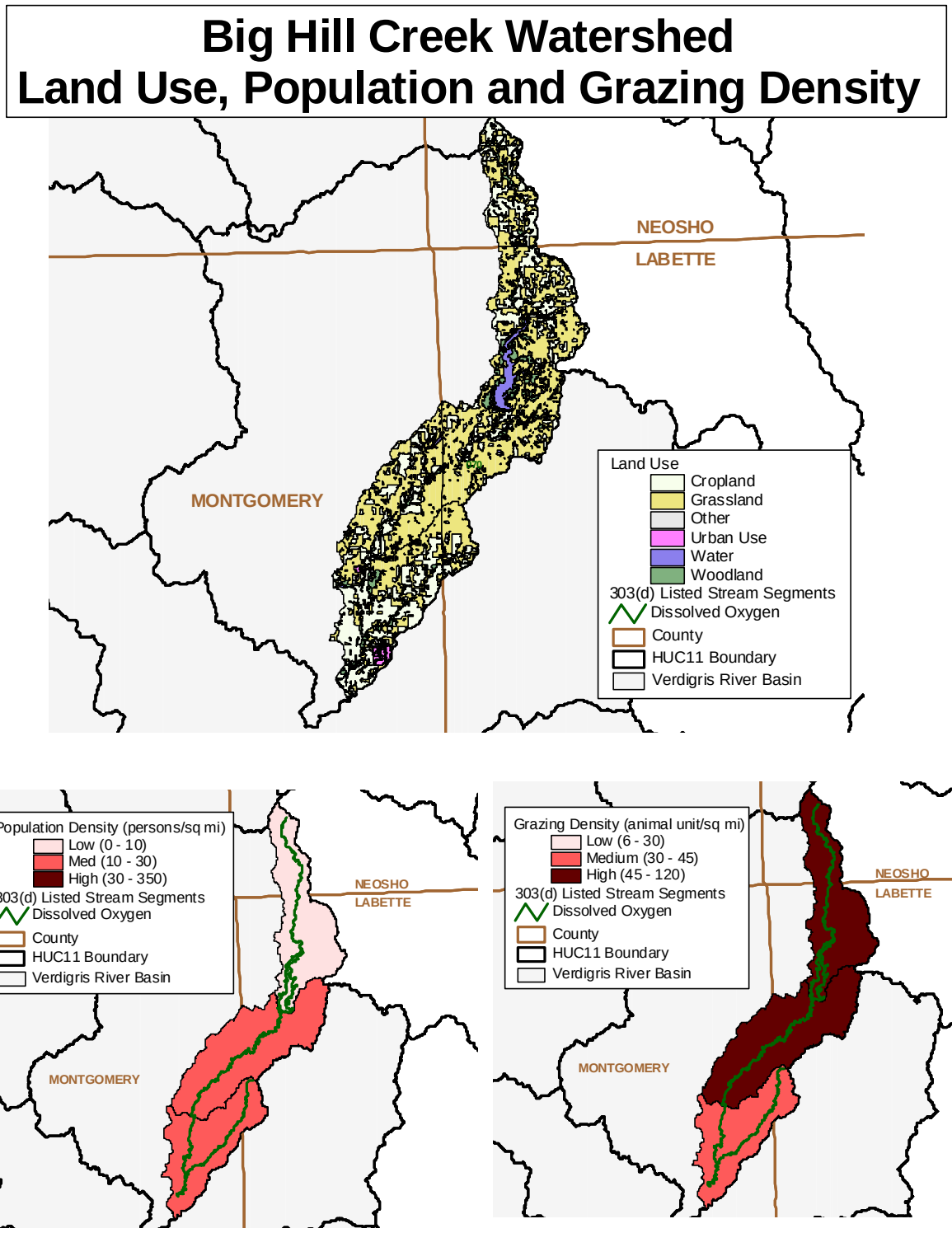
Big Hill Creek Watershed
Land Use, Population and Grazing Density
NEOSHO
LABETTE
MONTGOMERY
Land Use
Cropland
Grassland
Other
Urban Use
Water
Woodland
303(d) Listed Stream Segments
Dissolved Oxygen
County
HUC11 Boundary
Verdigris River Basin
Population Density (persons/sq mi)
Low (0 - 10)
Med (10 - 30)
High (30 - 350)
303(d) Listed Stream Segments
Dissolved Oxygen
County
HUC11 Boundary
Verdigris River Basin
NEOSHO
LABETTE
MONTGOMERY
Grazing Density (animal unit/sq mi)
Low (6 - 30)
Medium (30 - 45)
High (45 - 120)
303(d) Listed Stream Segments
Dissolved Oxygen
County
HUC11 Boundary
Verdigris River Basin
NEOSHO
LABETTE
MONTGOMERY

Figure 5

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

BOD is a measure of the amount of oxygen required to stabilize organic matter in a stream. As such, BOD is used as a benchmark measure to anticipate DO levels while it measures the total concentration of DO that will be demanded as organic matter degrades in a stream. It is presumed that reductions in BOD loads will reduce DO excursions under certain critical flow conditions. Therefore, any allocation of wasteloads and loads will be made in terms of BOD reductions. Yet, because DO is a manifestation of multiple factors, the initial pollution load reduction responsibility will be to decrease the BOD over the critical range of flows encountered on the Big Hill Creek system. These reductions have been based on the relationship between DO and BOD for the samples taken at Water Quality Monitoring site 607 as compared to the reference Middle Caney Creek watershed and its water quality monitoring site 694. Allocations relate to the BOD levels seen in the Big Hill Creek system at site 607 relative to site 694 for the critical lower flow conditions (0-0.72 cfs). Based on this relationship, BOD loads at site 607 need to be reduced on average by 50% (so that in stream average BOD is 2.4 mg/L or less). Additional monitoring over time will be needed to further ascertain the relationship between BOD reductions of non-point sources, flow conditions, and DO levels along the stream.

For this phase of the TMDL the average condition is considered across the seasons to establish goals of the endpoint and desired reductions. Therefore, the target average BOD level was multiplied by the average daily flow for Big Hill Creek across all hydrologic conditions. This is represented graphically by the integrated area under the BOD load duration curve established by this TMDL. The area is segregated into allocated areas assigned to point sources (WLA) and nonpoint sources (LA). Future growth in wasteloads should be offset by reductions in the loads contributed by nonpoint sources. This offset along with appropriate limitations is expected to eliminate the impairment. This TMDL represents the “Best Professional Judgment” as to the expected relationship between physical factors, organic matter and DO.

Point Sources: Point sources are responsible for maintaining their systems in proper working condition and appropriate capacity to handle anticipated wasteloads of their respective populations. The State and NPDES permits will continue to be issued on 5 year intervals, with inspection and monitoring requirements and conditional limits on the quality of effluent released from these facilities. Ongoing inspections and monitoring of the systems will be made to ensure that minimal contributions have been made by this source.

Based upon the preceding assessment, only those discharging point sources (Liberty) contributing a BOD load in the Big Hill Creek watershed upstream of site 607 will be considered in this Wasteload Allocation. Effluent monitoring records from Liberty for 1998 - 2001 indicate the city has discharged about 13% of the time and these discharges have reflected runoff events within the watershed (Appendix).

Streeter-Phelps analyses for this point source indicates the present BOD permit limit (30 mg/L) for it maintains DO levels above 5 mg/L in the stream when there is no flow upstream of the discharge point (see attached Streeter-Phelps analysis).

The design flow of the point source (0.03 cfs) redefines the lowest flow seen at site 607 (74-99% exceedance), and the WLA equals the TMDL curve across this flow condition (**Figure 6**).

From this, the WLA for the city of Liberty is 4.5 lbs/day BOD which translates to an in stream WLA of 0.36 lbs/day BOD at Site 607 (**Figure 6**).

Non-Point Sources: Based on the prior assessment of sources, the distribution of excursions from water quality standards at site 607 and the relationship of those excursions to runoff conditions and seasons, non-point sources are seen as a contributing factor to the occasional DO excursions in the watershed.

The samples from the Big Hill Creek watershed show there were no DO violations at flows in excess of 0.72 cfs. The Load Allocation assigns responsibility for reducing the in stream BOD levels at site 607 to 2.4 mg/L across the 0.03 - 0.72 cfs range of the critical flow condition (54 - 73% exceedance) and maintaining the in stream BOD levels at site 607 to the historical levels of 2.8 mg/L for flows in excess of 0.72 cfs (which is 90^{th} percentile of BOD samples for flows in Big Hill Creek above 0.72 cfs near Cherryvale). The LA equals zero for flows from 0 - 0.03 cfs (74 - 99% exceedance), since the flow at this condition is entirely effluent created, and then increases to the TMDL curve with increasing flow beyond 0.03 cfs (**Figure 6**). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows as well as reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period.

Defined Margin of Safety: The Margin of Safety will be implied based on conservative assumptions used in the permitting of the point source discharges including coincidence of low flow with maximum discharge from the treatment plant, associated CBOD content, temperature of the effluent, higher than expected stream velocity and the better than permitted performance of the treatment plant in producing effluent with BOD well below permit limits under critical seasonal conditions. Additionally, the target BOD concentration has been set at a conservative value since sampling data indicates exceeding this value has seldom led to a dissolved oxygen violation.

State Water Plan Implementation Priority: Because this watershed has indicated some problem with dissolved oxygen which has short term and immediate consequences for aquatic life, this TMDL will be a High Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Middle Verdigris Basin (HUC 8: 11070103) with a priority ranking of 26 (Medium Priority for restoration work).

Priority HUC 11s and Stream Segments: Priority should be directed toward baseflow gaining stream segments along the main stem of Big Hill Creek (30 and 32) downstream of Big Hill Lake, including Potatoe Creek (31).

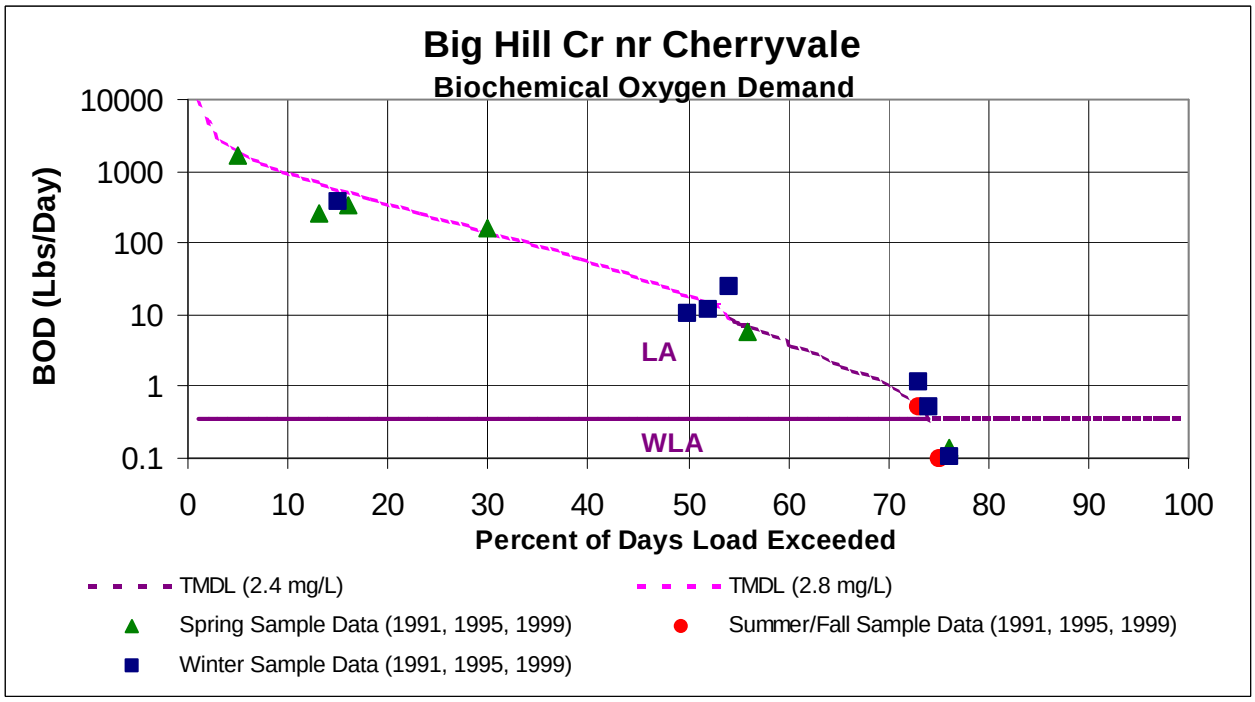

Figure 6

5. IMPLEMENTATION

Desired Implementation Activities

1. Where needed, restore riparian vegetation along target stream segments.
2. Install grass buffer strips where needed along streams.
3. Renew state and federal permits and inspect permitted facilities for permit compliance
4. Install proper manure and livestock waste storage.
5. Insure proper on-site waste system operations in proximity to targeted streams.
6. Insure that labeled application rates of chemical fertilizers are being followed.

Implementation Programs Guidance

NPDES and State Permits - KDHE

a. Municipal permits for facilities in the watershed will be renewed after 2006 with DO and BOD monitoring and permit limits preventing excursions in these criteria.

c. Livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.

d. Registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.

e. Manure management plans will be implemented to prevent introduction of organic material to the stream.

Non-Point Source Pollution Technical Assistance - KDHE

a. Support Section 319 demonstration projects for pollution reduction from livestock operations in watershed.

b. Provide technical assistance on practices geared to small livestock operations which minimize impact to stream resources.

c. Guide federal programs such as the Environmental Quality Improvement Program, which are dedicated to priority subbasins through the Unified Watershed Assessment, to priority stream segments within this TMDL.

Water Resource Cost Share & Non-Point Source Pollution Control Programs - SCC

a. Provide alternative water supplies to small livestock operations

b. Develop improved grazing management plans

c. Reduce grazing density on overstocked pasturelands

d. Install livestock waste management systems for manure storage

e. Implement manure management plans

f. Install replacement of on-site waste systems close to priority streams.

g. Coordinate with USDA/NRCS Environmental Quality Improvement Program in providing educational, technical and financial assistance to agricultural producers.

Riparian Protection Program - SCC

a. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.

b. Design winter feeding areas away from streams.

Buffer Initiative Program - SCC

a. Install grass buffer strips near streams.

b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance - Kansas State University

a. Educate livestock producers on riparian and waste management techniques.

b. Provide technical assistance on livestock waste management design.

c. Continue Section 319 demonstration projects on livestock management.

Agricultural Outreach - KDA

a. Provide information on livestock management to commodity advocacy groups.

b. Support Kansas State outreach efforts.

Local Environmental Protection Program - KDHE

a. Inspect and repair on-site waste systems within 500 feet of priority stream segments.

Timeframe for Implementation: Pollution reduction practices should be installed along Big Hill Creek and base flow gaining tributaries in 2003-2007, with follow up implementation thereafter.

Targeted Participants: Primary participants for implementation will be the identified point sources and landowners immediately adjacent to the priority stream segments. Implemented activities should be targeted to those stream segments with greatest potential contribution to baseflow. Nominally, this would be most likely be:

1. Areas of denuded riparian vegetation along Big Hill Creek, Potatoe Creek and their contributing tributaries.
2. Facilities with inadequate water quality controls
3. Unbuffered cropland adjacent to stream
4. Sites where drainage runs through or adjacent livestock areas
5. Sites where livestock have full access to stream and stream is primary water supply
6. Poor riparian sites
7. Failing on-site waste systems

Some inventory of local needs should be conducted in 2003 to identify such activities. Such an inventory would be done by local program managers with appropriate assistance by commodity representatives and state program staff in order to direct state assistance programs to the principal activities influencing the quality of the streams in the watershed during the implementation period of this TMDL.

Milestone for 2007: The year 2007 marks the mid-point of the ten year implementation window for the watershed. At that point in time, milestones should be reached which will have at least two-thirds of the landowners responsible for riparian restoration or buffer strips, cited in the local assessment, participating in the implementation programs provided by the state. Additionally, sampled data from site 607 should indicate evidence of improved dissolved oxygen levels at the critical flow conditions below 1 cfs relative to the conditions seen over 1991, 1995 and 1999. Information on the ability of aerators to improve lagoon effluent quality should be available in 2007.

Delivery Agents: The primary delivery agents for program participation will be the conservation districts for programs of the State Conservation Commission and the Natural Resources Conservation Service. Producer outreach and awareness will be delivered by Kansas State County staff managing. On-site waste system inspections will be performed by Local Environmental Protection Program personnel for primarily Labette and Montgomery counties.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a

potential to discharge pollutants into the waters of the state.

3. K.A.R. 28-16-69 to -71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

4. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

5. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control non-point source pollution.

6. K.S.A. 82a-901, *et seq*. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

7. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan*.

8. The *Kansas Water Plan* and the Verdigris Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund, annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This TMDL is a High Priority consideration.

Effectiveness: Buffer strips are touted as a means to filter sediment before it reaches a stream and riparian restoration projects have been acclaimed as a significant means of stream bank stabilization. The key to effectiveness is participation within a finite subwatershed to direct resources to the activities influencing water quality. The milestones established under this TMDL are intended to gauge the level of participation in those programs implementing this TMDL.

Should participation significantly lag below expectations over the next five years or monitoring indicates lack of progress in improving water quality conditions from those seen over 1991, 1995 and 1999, the state may employ more stringent conditions on agricultural producers and urban runoff in the watershed in order to meet the desired endpoints expressed in this TMDL. The state has the authority to impose conditions on activities with a significant potential to pollute the waters of the state under K.S.A. 65-171. If overall water quality conditions in the watershed deteriorate, a Critical Water Quality Management Area may be proposed for the watershed, in response.

6. MONITORING

KDHE will continue to collect bimonthly samples at rotational Station 607 in 2003, 2007 and 2011, including dissolved oxygen samples, in order to assess progress and success in implementing this TMDL toward reaching its endpoint. Should impaired status remain, the desired endpoints under this TMDL may be refined and more intensive sampling may need to be conducted under specified low flow conditions over the period 2007-2011. Use of the real time flow data available at the Big Hill Creek near Cherryvale stream gaging station can help direct these sampling efforts.

Monitoring of BOD levels in effluent will continue to be a condition of NPDES and state permits for facilities. This monitoring will continually assess the functionality of the systems in reducing organic levels in the effluent released to the streams.

Local program management needs to identify its targeted participants of state assistance programs for implementing this TMDL. This information should be collected in 2003 in order to support appropriate implementation projects.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Verdigris Basin were held January 23 in Fredonia and March 6, 2002 in Neodesha. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Verdigris Basin.

Public Hearing: A Public Hearing on the TMDLs of the Verdigris Basin was held in Neodesha on June 4, 2002.

Basin Advisory Committee: The Verdigris Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2001, January 23 and March 6, 2002.

Milestone Evaluation: In 2007, evaluation will be made as to the degree of impairment which has occurred within the watershed and current condition of Big Hill Creek. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The stream will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize implementation of TMDLs. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

Appendix (Big Hill Creek DO TMDL)

Table 2

Big Hill Cr Watershed (607)			Middle Caney Cr Wtrshd (694)		
Land Use	Acres	% of Total	Land Use	Acres	% of Total
Cropland	23496	33.0	Cropland	2436	3.2
Grassland	40307	56.7	Grassland	68986	91.0
Urban Use	742	1.0	Urban Use	470	0.6
Water	1839	2.6	Water	709	0.9
Woodland	4741	6.7	Woodland	3172	4.2
Total	71126	100	Total	75773	100

Table 3

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		Flow (est)
	607	694	607	694	607	694	607	694	607	694	607	694	607	694	607	694	607	694	607	694	607
1/18/95	11.6	12.4	0.010	0.010	2.30	2.50	20	200	0.08	0.07	7.9	8.1	2	2	0.010	0.010	7	5	2.8	4.2	1
3/21/95	7.2	8.2	0.010	0.010	1.60	1.00	90	100	0.03	0.14	7.8	8.0	13	14	0.060	0.150	35	30	11.0	20.0	1.2
5/16/95	8.2	6.8	0.070	0.070	1.90	2.40	300	1700	0.24	0.17	7.6	7.8	18	20	0.060	0.060	49	49	12.0	18.0	33
7/18/95	**4.0**	5.5	0.010	0.010	1.90	2.20	300	200	0.20	0.04	7.5	7.7	23	25	0.080	0.040	58	16	23.0	7.0	0.57
9/19/95	*6.2*	*4.9*	*0.352*	*0.366*	*2.50*	*1.70*	*500*	*100*	*0.12*	*0.04*	*7.6*	*7.7*	*19*	*19*	*0.061*	*0.024*	*29*	*14*	*4.0*	*5.0*	*0.04*
11/14/95	**2.5**	5.6	0.033	0.050	5.60	1.70	100	10	0.04	0.04	7.5	7.5	3	6	0.238	0.023	10	10	6.0	4.0	0.04
3/1/99	10.9	9.8	0.020	0.020	1.95	2.70	80	70	0.28	0.12	7.9	8.0	13	13	0.040	0.050	20	17	8.0	9.0	37
5/3/99	8.6	7.8	0.030	0.030	1.00	1.59	260	220	0.50	0.26	7.6	7.8	19	19	0.090	0.060	52	25	25.0	15.0	48
6/28/99	7.0	6.5	0.020	0.020	2.40	1.95	2400	500	0.26	0.20	7.7	7.9	27	26	0.090	0.070	146	49	51.0	33.0	128
8/30/99	*7.0*	*7.0*	*0.020*	*0.090*	*1.00*	*1.00*	*190*	*30*	*0.06*	*0.14*	*7.8*	*7.8*	*29*	*30*	*0.040*	*0.040*	*9*	*12*	*6.4*	*6.2*	*0.001*
11/1/99	**2.9**	3.1	0.020	0.020	6.93	3.27	80	40	0.03	0.01	7.5	7.6	17	17	0.240	0.068	27	12	7.4	8.0	0.66
Avg	6.4	6.1	0.023	0.040	2.83	1.95	733	198	0.21	0.15	7.7	7.8	23	23	0.115	0.060	59	25	22.45	15.55	44.17

Table 4

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		Flow (est)
	605	565	605	565	605	565	605	565	605	565	605	565	605	565	605	565	605	565	605	565	607
7/18/95	**4.0**	5.5	0.010	0.010	1.90	2.20	300	200	0.20	0.04	7.5	7.7	23	25	0.080	0.040	58	16	23.0	7.0	0.57
11/14/95	**2.5**	5.6	0.033	0.050	5.60	1.70	100	10	0.04	0.04	7.5	7.5	3	6	0.238	0.023	10	10	6.0	4.0	0.04
11/1/99	**2.9**	3.1	0.020	0.020	6.93	3.27	80	40	0.03	0.01	7.5	7.6	17	17	0.240	0.068	27	12	7.4	8.0	0.66
Avg	3.1	4.7	0.021	0.027	4.81	2.39	160	83	0.09	0.03	7.5	7.6	14	16	0.186	0.044	32	13	12.13	6.33	0.423

Table 5

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		Flow (est)
	605	565	605	565	605	565	605	565	605	565	605	565	605	565	605	565	605	565	605	565	607
9/19/95	*6.2*	*4.9*	*0.352*	*0.366*	*2.50*	*1.70*	*500*	*100*	*0.12*	*0.04*	*7.6*	*7.7*	*19*	*19*	*0.061*	*0.024*	*29*	*14*	*4.0*	*5.0*	*0.04*
8/30/99	*7.0*	*7.0*	*0.020*	*0.090*	*1.00*	*1.00*	*190*	*30*	*0.06*	*0.14*	*7.8*	*7.8*	*29*	*30*	*0.040*	*0.040*	*9*	*12*	*6.4*	*6.2*	*0.001*
Avg	6.6	6.0	0.186	0.228	1.75	1.35	345	65	0.09	0.09	7.7	7.8	24	25	0.051	0.032	19	13	5.20	5.60	0.021

Liberty

Date	BOD	Average Monthly Q	Average Daily Q	Flow Condition Comments
12/1/01	no disch	0.003		
11/1/01	no disch	0.024		
10/1/01	no disch	0.108		
9/1/01	no disch	0.03		
8/1/01	no disch	0		
7/1/01	no disch	0.27		
6/1/01	no disch	14		
5/1/01	no disch	0.035		
4/20/01	16.7	10	0	Dry period
3/1/01	no disch	73		
2/1/01	no disch	26		
1/1/01	no disch	0.11		
12/1/00	no disch	0.023		
11/1/00	no disch	0.023		
10/1/00	no disch	0.33		
9/1/00	no disch	0.016		
8/1/00	no disch	0.005		
7/1/00	no disch	11.9		
6/1/00	no disch	122		
5/1/00	no disch	29		
4/1/00	no disch	15.4		
3/1/00	no disch	15.3		
2/1/00	no disch	9.7		
1/1/00	no disch	0.14		
12/1/99	no disch	0.34		
11/1/99	no disch	2.8		
10/1/99	no disch	0.42		
9/1/99	no disch	0.16		
8/1/99	no disch	0.01		
7/1/99	14.5	19.8	136	Six days after runoff event peak of 466. Effluent sample date was on peak
6/1/99	no disch	106		
5/20/99	84	91.2	76	Two days after runoff event of 150; and 8 days after peak of 380
4/1/99	no disch	79		
3/1/99	no disch	51		
2/5/99	24.5	65	64	11 days after runoff event peak of 70 cfs
1/1/99	no disch	19		
12/1/98	no disch	25		
11/19/98	11	56	22	Nine days after runoff event of 150 cfs
10/1/98	no disch	136		
9/1/98	no disch	1.3		
8/1/98	no disch	0.06		
7/1/98	no disch	0.42		
6/1/98	no disch	8.7		
5/1/98	no disch	14.9		
4/2/98	18.9	33.6	34	Two weeks after runoff event peak of 301 cfs
3/1/98	no disch	46.5		
2/1/98	no disch	0.62		
1/1/98	no disch	122		

Streeter-Phelps DO Sag Model - BigHillCrDO_Liberty
Single Reach - Single Load

1 cfs = .0283 m^3/s
0.25 mph =0 .11176 m/s

		Elev (ft)	Dist to 607	Min DO	Crit Dist DO
0.0007924	Design Flow (Liberty)	740	12.30	5.01	12.17

Elevation Correction (DO)

Elevation	**740**	ft
Correctn Factor (DO_{sat})	0.97632	mg/L

Distance (km)
Flow (m^3/s)
Concentration (mg/L)
Temp (C)
Vel (m/s)

Unless modified by upstream pt. source, upstream BOD set as target for basin

Upstream DO (where appropriate) elevation corrected and set at 90% sat.

Velocity	0.11176		
BOD coef	0.23	Theta	1.056
O2 coef	1.29	Theta	1.024

		Flow	BOD	DO	T	Dist	Slope (ft.mi)	Calc K_r	
1	**Liberty**	0.0007924	29	6.85	20	12.3	4.84	1.29	
	Upstream	0	0	0	0	-----			
	Result at Dist (site 607)	0.0007924	21.53	5.01	23.3				Elev = 703 ft

Kr Values (Foree 1977) usin 0.42 (0.63 + 0.4S^1.15)
for q < 0.05 where q = cfs/mi^2 S (ft/mile)